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TM-102800-B

INSTRUCTION MANUAL
FOR
PHASEMETER
MODEL 331B

1 JANUARY 1978

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TABLE OF CONTENTS

Section		Page
I	GENERAL INFORMATION	1-1
	1-1. Introduction	1-1
	1-2. Purpose	1-1
	1-3. Special Features	1-1
	1-4. Equipment Characteristics	1-1
	1-5. Options	1-4
II	OPERATION	2-1
	2-1. General	2-1
	2-2. Controls, Connectors and Indicators	2-1
	2-3. Unpacking	2-1
	2-4. Operation	2-1
	2-5. Rear Connector Pin Assignments	2-3
III	PERFORMANCE CHECK	3-1
	3-1. General	3-1
	3-2. Test Equipment Required	3-1
	3-3. Calibration	3-1
	3-4. Minimum Performance Check	3-2
IV	THEORY OF OPERATION	4-1
	4-1. General	4-1
	4-2. Basic Operation of 360° Zero Crossing Phasemeters	4-1
	4-3. Phasemeter Block Diagram Description	4-1
V	MAINTENANCE	5-1
	5-1. General	5-1
	5-2. Disassembly	5-1
	5-3. Power Supply Removal	5-2
	5-4. Panel Meter Removal	5-8
	5-5. Circuit Description	5-8
VI	FULL CALIBRATION PROCEDURE	6-1
	6-1. General	6-1
	6-2. Equipment Required	6-1
	6-3. Equipment Setup	6-1

TABLE OF CONTENTS (cont)

Section		Page
VI	FULL CALIBRATION PROCEDURE (cont)	
	6-4. Test Procedure	6-3
	6-5. Calibration	6-3
	6-6. Adjustment Procedure	6-4
VII	REPLACEABLE PARTS LIST	7-1
	7-1. General	7-1

LIST OF ILLUSTRATIONS

Figure		Page
1-1	Model 331 Phasemeter	1-2
2-1	Phasemeter Front Panel	2-2
2-2	Phasemeter Rear Panel	2-2
3-1	Minimum Performance Test Circuit Setup	3-2
4-1	Timing Diagram for 360° Zero Crossing Phasemeters	4-2
4-2	Phasemeter, Block Diagram	4-3
4-3	Level Sensing Circuits, Detailed Block Diagram	4-5
4-4	Mode Ranging Circuits, Block Diagram	4-7
5-1	Top View, Phasemeter Removed from case	5-2
5-2	Phase Detector Board A1, Parts Location	5-3
5-3	Input Board A2, Parts Location	5-5
5-4	Power Supply Assembly A3, Parts Location	5-7
5-5	Phase Detector A1, Schematic Diagram (3 sheets)	5-15
5-6	Input Board A2, Schematic Diagram (2 sheets)	5-21
5-7	Dual Power Supply, Schematic Diagram	5-25
5-8	Phasemeter Interconnection Diagram	5-27
6-1	Test Circuit	6-2
6-2	High Frequency Attenuator, Dranetz Assembly #101,573	6-2
6-3	Input Board A2, Location of Adjustments	6-5

LIST OF ILLUSTRATIONS (cont)

Figure		Page
6-4	Phase Detector Board A1, Location of Adjustments	6-5
6-5	Test Data Sheet with DC Meter Readings	6-10
6-6	Test Data Sheet with Digital Panel Readings	6-10

LIST OF TABLES

1-1	Technical Characteristics	1-2
2-1	Front Panel Operating Controls, Indicators and Connectors	2-4
2-2	Rear Panel Connectors and Fuse	2-6
2-3	Connector P1B, Pin Assignments	2-7
2-4	Rear Panel Connector P1A, Digital Output, for Phasemeter with Option 101	2-8
3-1	Phasemeter Data Sheet with Maximum Tolerances	3-4

SECTION I

GENERAL INFORMATION

1-1. INTRODUCTION

This manual provides operating and service instructions for the Model 331B Phasemeter (hereinafter referred to as the Phasemeter), manufactured by Dranetz Engineering Laboratories, Incorporated. (See figure 1-1.) This section describes the purpose, application, and technical characteristics of the Phasemeter.

1-2. PURPOSE

The Phasemeter represents a totally new concept in high accuracy measurement of phase angle. A precision phase angle measurement is obtained simply by connecting the signals, setting the level range switches and reading the digital display. The Phasemeter senses the signal frequency and adjusts its output time constant for maximum speed commensurate with low ripple. It accepts sine, square and other waveforms without the need for function switching.

The Phasemeter can be checked and adjusted by means of front panel CALIBRATE switches and screwdriver controls. These manual controls provide adjustment for zero and full scale calibration of the analog DC output as well as the digital panel reading.

1-3. SPECIAL FEATURES

The Phasemeter provides several advanced features.

a. Accuracy to 0.1°.

b. Frequency range 5 Hz - 500 kHz.

c. 4-digit digital display.

d. 1 megohm input impedance.

e. Indicator lights on each input to indicate either low or high input levels.

f. Hold last phase measurement capability.

1-4. EQUIPMENT CHARACTERISTICS

The technical characteristics of the Phasemeter are summarized in Table 1-1.

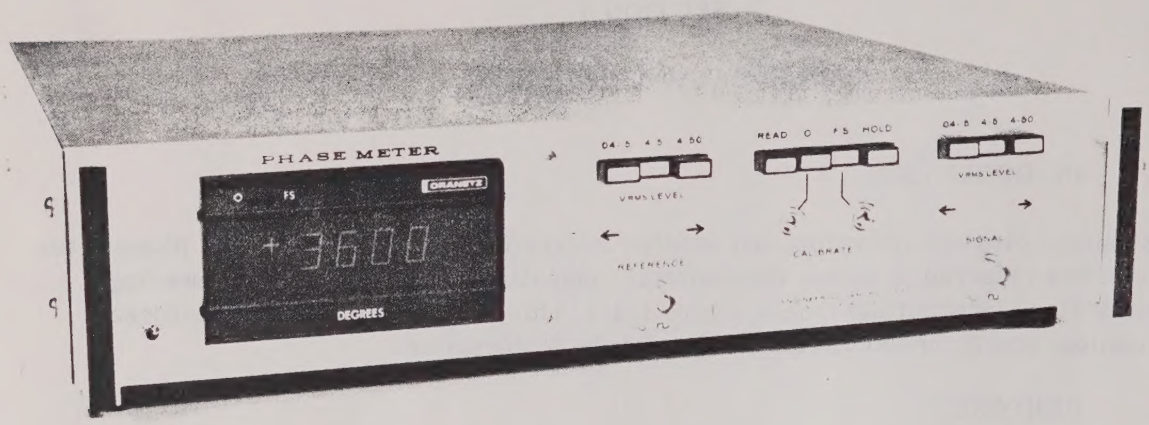

Figure 1-1. Model 331B Phasemeter

Table 1-1. Technical Characteristics

Frequency Range	5 Hz to 500 kHz
Accuracy (50 mV to 50V RMS)	
Sine Wave	±0.1° ±1 digit from 50 Hz to 50 kHz; ±0.2° ±1 digit from 10 Hz to 100 kHz; ±0.2° per 100 kHz to 500 kHz
Square Wave	±0.1° ±1 digit from 10 Hz to 20 kHz; ±0.5° per 100 kHz above 20 kHz
Angle Ranges	000.00° to 360.00° or -180.00° to +180.00° automatic or selectable
Display	Beckman (Sperry) 0.6" 4 digit
Resolution	0.1°
AC Circuit Phase Drift (30 day period):	
Sine Wave	<.06°
Square Wave	<.06°

Table 1-1. Technical Characteristics (cont)

Repeatability (DC)	Better than 0.1° after manually readjusting 0 and full scale
Temperature Coefficient	0.01°/°C over frequency range
Input Signal Amplitudes	0.05 to 250V RMS in 3 ranges (0.05-0.5V, 0.4-5V, 4-50V with overrange to 250V RMS); can be extended with Tektronix probes
Input Impedance	1 megohm shunted by 50pF nominal
Response Time	700 milliseconds
Maximum DC Components	±200 Volts; can be extended with probes
Analog Output	0.0000 to 3.6000V and -1.8000 to +1.8000V DC, +10.0mv DC/degree phase; output impedance less than 100 ohms; DC drift ±0.1°/30 days
Ambient Temperature	0°C to 45°C
Panel Controls and Adjustments	3 range input level pushbuttons each channel; read-hold; power; 0° CAL and 360° CAL adjustments
Connectors	BNC, both input channels, rear and front; PC rear for analog output
Power Requirements	105-125 to 210-250 Volts, 50/60 Hz, 70 Watts
Dimensions	3-1/2" high x 16" deep, 19" rack/portable package
Weight	18 pounds (8 kilograms) net weight; 22 pounds (10 kilograms) shipping
Option	#101: BCD output, TTL/DTL, 8421

1-5. OPTIONS

Two options are available with the Phasemeter. When Option 101 is included, a connector (P1A) supplied at the rear panel provides digital outputs that represent the displayed angle. The digital signals are in BCD (binary coded decimal, 8421) form and are TTL/DTL compatible. The second option is a fixture that enables mounting the Phasemeter in a rack.

SECTION II

OPERATION

2-1. GENERAL

This section contains the operating procedures for the Phasemeter. Operating controls, indicators, and connectors are referred to by the nomenclature that appears on the front and rear panels.

2-2. CONTROLS, INDICATORS AND CONNECTORS

Figures 2-1 and 2-2 identify the operating controls, indicators and connectors of the Phasemeter. These illustrations are supported by tables 2-1 and 2-2, respectively, which list the index number, nomenclature and the function of those items called out in the figure.

2-3. UNPACKING

Unpack the Phasemter and visually inspect thoroughly for possible shipping damage. IF DAMAGE EXISTS, NOTIFY DRANETZ ENGINEERING LABORATORIES AND CARRIER, AND RETAIN SHIPPING CARTONS. DO NOT RETURN WITHOUT INSTRUCTIONS FROM MANUFACTURER.

2-4. OPERATION

To prepare the Phasemeter for operation, proceed as follows:

a. Connect the power cord supplied between the AC power receptacle (figure 2-2) and a 50 to 60 Hz power source having the nominal voltage specified on rear panel.

b. For normal operation, the three terminals on the rear mounted ground terminal board should be connected together.

c. Turn the PWR switch to the "on" position.

d. Depress the READ/HOLD switch to the READ position.

e. Set the REFERENCE channel level range switches to correspond to the Reference input level to be measured.

f. Set the SIGNAL channel level range switches to correspond to the Signal input level to be measured.

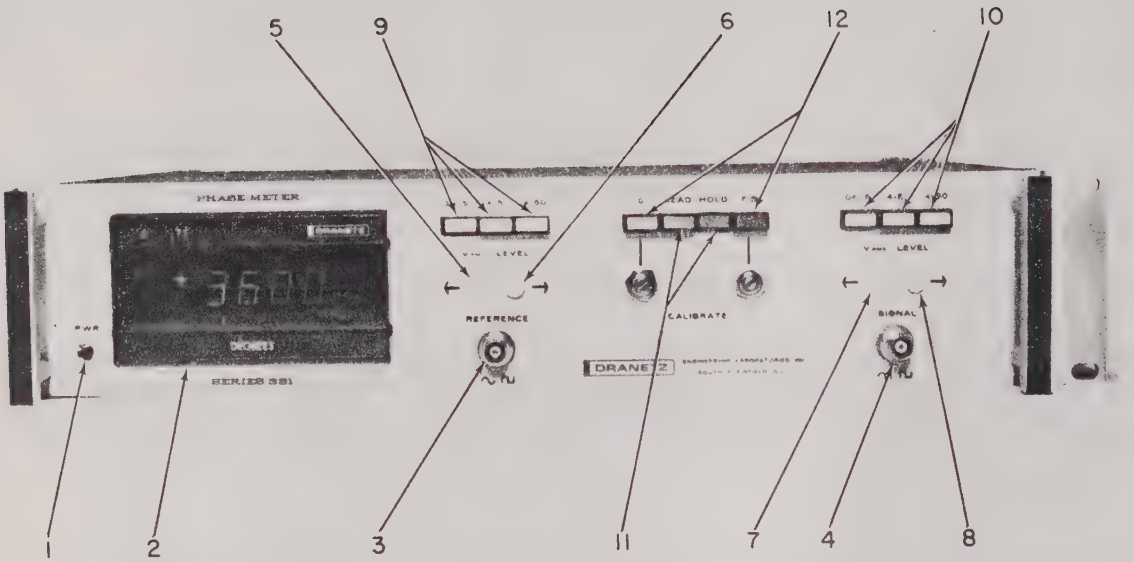

Figure 2-1. Phasemeter Front Panel

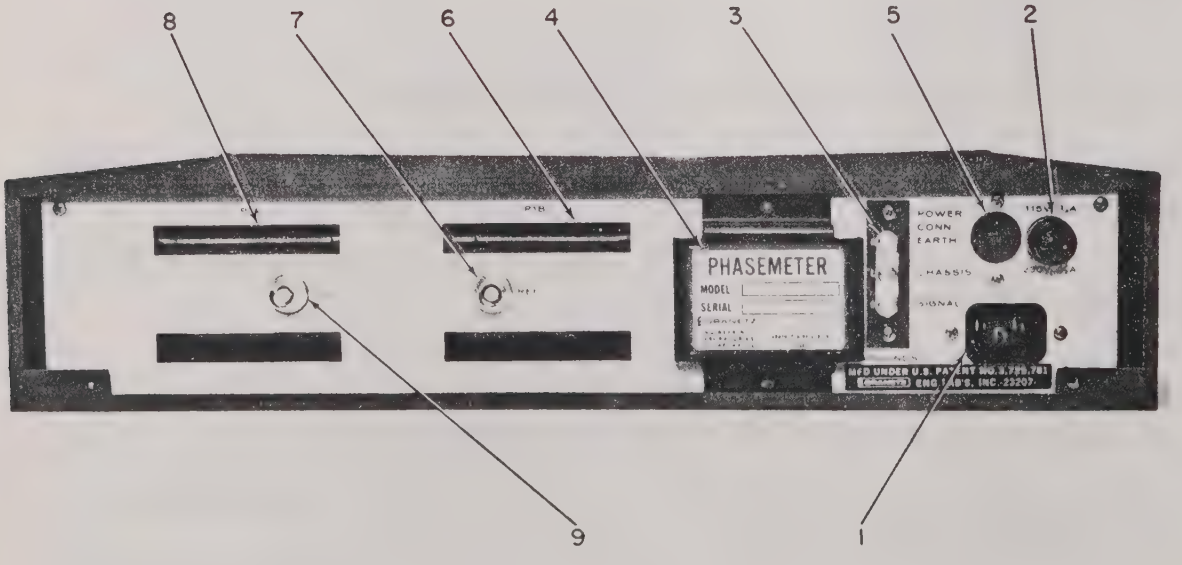

Figure 2-2. Phasemeter Rear Panel

g. Connect the Reference and Signal inputs to their respective BNC connectors.

h. Observe that the high-low level indicators are off, indicating the correct level range has been selected. If level indicators remain on, select level range to satisfy the high-low indicators.

i. Read the phase angle on the digital display.

j. To check Phasemeter calibration, depress the "0" calibrate pushbutton, and the "F. S." (360°) calibrate pushbutton. If range end points are in error by more than ±0.1°, perform the adjustment shown in Section III.

NOTE

When the Phasemeter is to be put into operation for the first time, a minimum performance check should be made to insure that no damage has been incurred to the unit during shipment. (See Section III.)

2-5. REAR CONNECTOR PIN ASSIGNMENTS

For connection to external meters or recorders, or for remote control of the unit, rear connector pin assignments are provided in tables 2-3 and 2-4.

Table 2-1. Front Panel Operating Controls, Indicators and Connectors

Index No.	Controls, Indicator or Connector	Function
1	PWR switch	Applies AC power in the on (up) position
2	Digital panel meter	4 digit, -180.0° to +360.0° readout
3	REFERENCE connector	BNC type connector for input signal used to establish the phase reference for the Signal input. (Input impedance = 1 megohm shunted by 50 pf)
4	SIGNAL connector	BNC type connector for input whose phase shift is measured with respect to the Reference input. (Input impedance = 1 megohm shunted by 50 pf)
5	Low reference indicator lamp	Lights when the Reference level drops below the selected attenuator's lower limit
6	High reference indicator lamp	Lights when the Reference level rises above the selected attenuator's upper limit
7	Low signal indicator lamp	Lights when the Signal level drops below the selected attenuator's lower limit
8	High signal indicator lamp	Lights when the Signal level rises above the selected attenuator's upper limit
9	Reference level range select switches	Selects one of three input ranges: .040 to 0.5V rms 0.4 to 5.0V rms 4.0 to 50V rms (High-Low level indicators aid operator in selecting the proper range)
10	Signal level range select switches	Same function as Reference channel level range switches, but for Signal channel

Table 2-1. Front Panel Operating Controls, Indicators and Connectors (cont)

Index No.	Controls, Indicator or Connector	Function
11	READ/HOLD switch	Controls the front panel digital meter. With READ switch depressed, digital display follows phase angle variations. With HOLD switch depressed, last measured phase angle is frozen on display.
12	0 and F.S. calibration pushbuttons	When "0" pushbutton is depressed, the 0° calibration point may be set with the corresponding front panel screwdriver control. When the "F.S." pushbutton is depressed, the full scale or 360° calibration point may be set with the corresponding front panel screwdriver control.

Table 2-2. Rear Panel Connectors and Fuse

Index No.	Controls, Indicator or Connector	Function
1	AC power connector	AC power input connector: 3 wire with ground
2	Fuse	MDL 3/4A for 115V, 50 to 60 Hz MDL 1/2A for 230V, 50 to 60 Hz
3	POWER CONN EARTH, CHASSIS and SIGNAL	A terminal board which provides for isolation of signal ground from case and/or power line. Normally the three terminals are connected together.
4	Power Transistor Cover	Provides protection for Power Supply transistors
5	Power line nominal voltage switch	After removal of cover, allows selection of either 115 or 230 volt rms nominal power line voltages
6	Connector P1B	Provides for connection to internal circuits
7	REF (reference) input connector	Provides rear panel access to Reference channel input
8	Connector P1A	Provides for connection to internal circuits
9	SIG (signal) input connector	Provides rear panel access to Signal channel input

Table 2-3. Connector P1B, Pin Assignments

Pin No.	Function
1	Mode Select: 0° to 360°
2	Mode Select: -180° to 180°
	Momentarily connect -24V dc to designated pin to select mode. Maintain connection if override of automatic circuits is desired.
6	Analog Output: -1.800V to +3.600V dc
9	Ckt. Gnd.
13 14 15	Override of automatic time constant selection is provided by connecting +24V or -24V to the pins as indicated below.
R	-24V dc
S	+24V dc

Pin	Automatic	TC = 10 MS (>5 kHz)	TC = 50 MS (0.5 - 5 kHz)	TC = 350 MS (50 - 500 Hz)	TC = 700 MS (<50 Hz)
13	Open	+24V	+24V	+24V	-24V
14	Open	+24V	+24V	-24V	-24V
15	Open	+24V	-24V	-24V	-24V

Table 2-4. Rear Panel Connector P1A, Digital Output, for Phasemeter with Option 101

NOTE

TTL/DTL COMPATIBLE
$\overline{N}$ = <+0.8V at -2 ma
N = >2.4V with 3.6K ohms source

Pin No.	Digital Outputs
1	N.C.
2	N.C.
3	N.C.
4	N.C.
5	N.C.
6	1 — BCD Tenths (L.S.D.)
7	2 — BCD Tenths (L.S.D.)
8	4 — BCD Tenths (L.S.D.)
9	8 — BCD Tenths (L.S.D.)
10	Digital Ground
11	1 — BCD Units
12	2 — BCD Units
13	4 — BCD Units
14	8 — BCD Units
15	Digital Ground
A	1 — BCD Tens
B	2 — BCD Tens
C	4 — BCD Tens
D	8 — BCD Tens
E	Digital Ground
F	1 — BCD Hundreds (M.S.D.)
H	2 — BCD Hundreds (M.S.D.)
J	4 — BCD Hundreds (M.S.D.)
K	8 — BCD Hundreds (M.S.D.)
L	Digital Ground
M	N.C.
N	Polarity bit, "1" for positive

Table 2-4. Rear Panel Connector P1A, Digital Output, for Phasemeter with Option 101 (cont)

Pin No.	Digital Outputs
P	Data Ready ("0" during conversion)
R	Sample rate adjust; "0" for 60 Hz rate, Open for 4 Hz rate
S*	Read/Hold; Gnd for READ, Open or high for HOLD

*For external control of READ/HOLD, place front panel READ/HOLD switch in HOLD position

SECTION III

PERFORMANCE CHECK

3-1. GENERAL

The performance check procedures enable the operator to determine if the Phasemeter is operating properly. This check can be performed either after setting up the equipment or when a malfunction has been remedied.

3-2. TEST EQUIPMENT REQUIRED

The following test equipment is required to perform the minimum performance check:

a. Broadband AC Voltmeter, Ballantine Model 303 or equivalent.

b. Broadband (5 Hz to 500 kHz) Oscillator with low distortion, General Radio Model 1310A or equivalent.

c. Precision DC Voltmeter (-2.0 to +4.0 vdc, 0.1 mv resolution, with error $\leq$ 0.3 mv.), Fluke Model 8300A or equivalent.

d. Two shielded cables terminated in BNC connectors on each end and one BNC T-connector. The shielded cables must have lengths not in excess of 18 inches and must match each other to within 1/2 inch.

3-3. CALIBRATION

a. Connect voltmeter to the DC analog output of the Phasemeter (pins 6 and 9, P1B, rear panel).

NOTE

The front panel DPM is not recommended for analog voltage calibration. Higher analog output accuracy can be obtained with the precision voltmeter which should be used for analog voltage measurements.

b. Allow a warm-up period as recommended by the manufacturer of the laboratory voltmeter and at least 1/2 hour for the Phasemeter.

c. Depress the "0" calibrate pushbutton and record the reading. It should be 0.0° $\pm$ 0.1° DPM; 0.0 mV $\pm$ 0.3 mV analog.

d. Depress the "F.S." calibrate pushbutton and record the reading. It should be 360.0° ± 0.1° DPM; 3600.0 mV ± 0.3 mV analog.

e. If the calibration points are in error by more than ± 0.1°, ± 0.3 mV analog, perform steps f thru h.

f. Depress the "O" calibrate pushbutton and adjust the screwdriver control below it for a 0° reading (0.0 mV analog).

g. Depress the "F.S." calibrate pushbutton and adjust the screwdriver control below it for a 360.0° reading (3600.0 mV analog).

h. Repeat steps d thru g, readjusting if necessary, until specified readings are obtained.

NOTE

If the digital readout is in error, it may be adjusted by screws on the DPM as described in the DPM instruction manual.

3-4. MINIMUM PERFORMANCE CHECK

Prior to performing the minimum performance check in the following steps, perform the calibration procedure detailed in paragraph 3-3. Adjust in accordance with the instructions if end point error exceeds ±0.1°. Make sure to set panel meter calibration points after calibration.

Connect equipment as shown in figure 3-1 and proceed with the following tests.

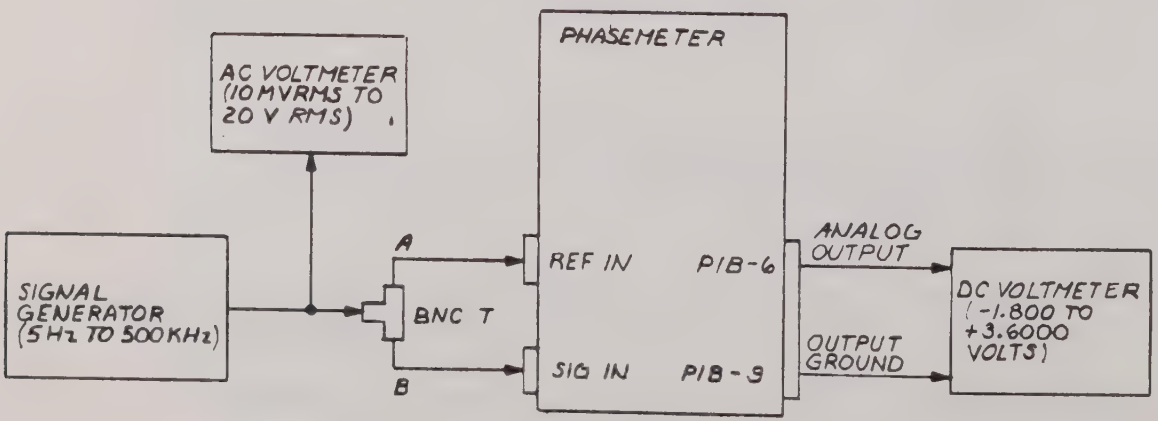

Figure 3-1. Minimum Performance Test Circuit Setup

3-5. Level Sensing Check.

a. Set level range switches of both input channels to .04-.5V rms. Set oscillator frequency to 1 kHz. Set input levels to 25 millivolts rms. Both low level indicators on the front panel should be lit.

b. Increase input signal levels to 60 millivolts rms. Both low level indicators on the front panel should extinguish.

c. Increase input signal levels to 1 volt rms. Each high level indicator should light. Set level range switches to .4-5V rms. Both high level indicators should extinguish.

d. Increase input signal levels to 10 volts rms. Each high level indicator should light. Set level range switches to 4-50V rms. Both high level indicators should extinguish.

3-6. Phase Error Check Over Full Frequency Range.

a. Set input levels to 200 millivolts rms. Set level range switches of both input channels to .04-.5V rms.

b. Set the various frequencies indicated in table 3-1. Record both panel meter reading and analog output voltage at each frequency.

c. If all data recorded is within the limits specified in table 3-1, the phasemeter is functioning normally. Specification limits on the analog output allow for 0.03 degrees (0.3 mv) error in the DC voltmeter used to make the measurements.

Table 3-1. PHASEMETER DATA SHEET WITH MAXIMUM TOLERANCE

Test Frequency	Panel Meter Reading in Degrees	Panel Meter Reading Tolerance (± Degrees)	Analog Output Reading in Millivolts	Analog Output Tolerance (± Millivolts)
5		1.1		10.3
50		0.2		1.3
100		0.2		1.3
1,000		0.2		1.3
10,000		0.2		1.3
50,000		0.2		1.3
500,000		1.1		10.3

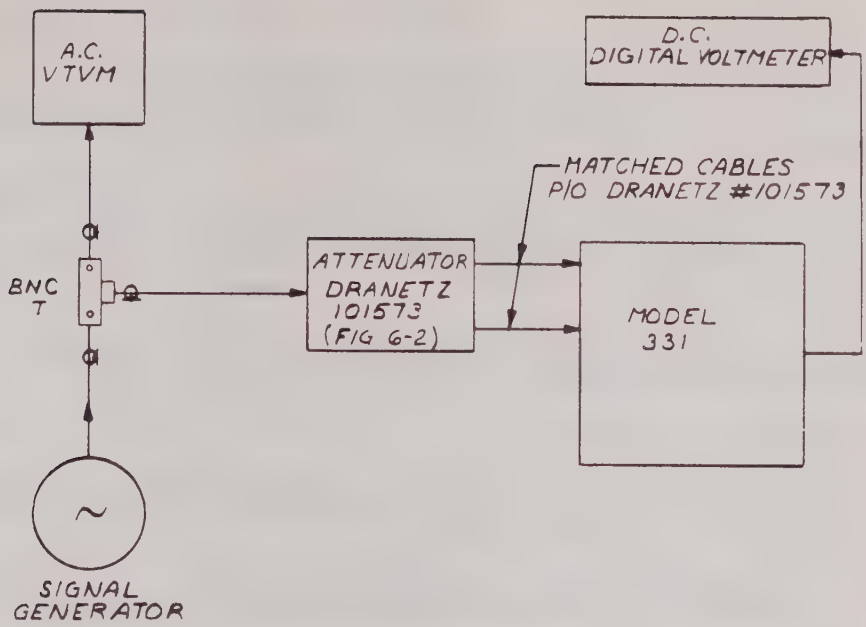

Figure 6-1. Test Circuit

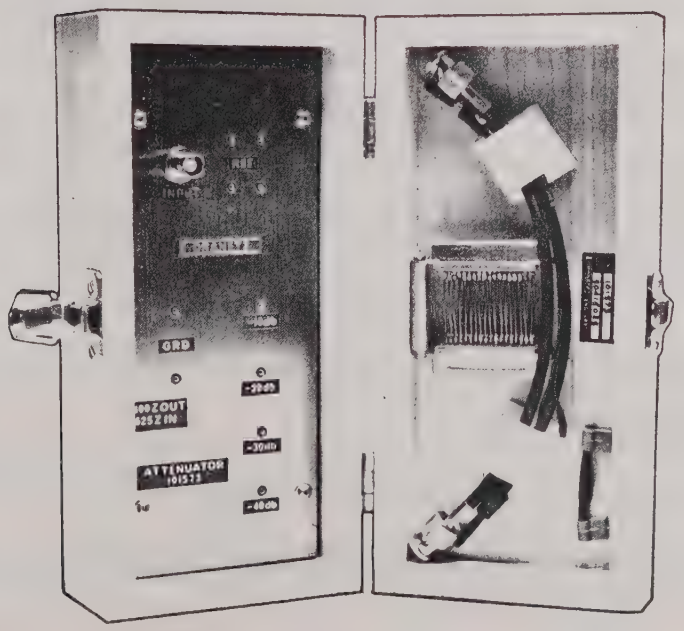

Figure 6-2. High Frequency Attenuator
Dranetz Assembly #101,573

SECTION VI

FULL CALIBRATION PROCEDURE

6-1. GENERAL

This section describes the calibration adjustments which may be made by the Calibration Laboratory. Note that the sequence of adjustments must be maintained in order that proper alignment be attained.

All or part of the calibration procedure may be necessitated by repairs or component replacement in boards A1 and A2.

6-2. EQUIPMENT REQUIRED

a. Broadband Oscillator with low distortion (5 Hz to 500 kHz), General Radio Model 1310A or equivalent.

b. Broadband AC Voltmeter, Ballantine Model 303 or equivalent.

c. Precision DC Voltmeter (-1.8 to +3.6 vdc with error $\leq$ 0.3 mv.) Fluke Model 8300A or equivalent.

d. Oscilloscope, General Purpose, Fairchild Model 704 or equivalent.

e. High frequency attenuator (100 ohms Z out, 600 ohms Z in; 0, 14, 20, and 40 dB). (See figure 6-2.)

f. Two matched cables (0.04"D pins to BNC, 15 to 20 pf capacity).

g. 1K ohm $\pm$1% resistor with 0.04"D pin on one end and 40 mil socket on other end.

NOTE

Items e, f, and g may be purchased as Dranetz Assembly #101,573.

6-3. EQUIPMENT SETUP

a. Connect the equipment as shown in figure 6-1.

b. If the complete procedure is to be performed, it should be done in the order listed below.

6-6. ADJUSTMENT PROCEDURE

6-7. Input Amplifier Bias Levels

a. Connect SIGNAL input connector to one 0 dB output of attenuator and REFERENCE input connector to other 0 dB output.

b. Set signal generator to 1 KHz and output level to zero.

c. Depress both .04-.5V RMS level range pushbutton switches on the front panel of the Phasemeter.

d. Monitoring the outputs of both input amplifiers at the emitters of Q101 and Q201 on board A2 with an oscilloscope, increase the input level until clipping is observed.

e. Adjust bias potentiometers R110 and R209 on board A2 (fig. 6-3) for symmetrical clipping.

f. Reduce input level to the point just below clipping (maximum undistorted output.) The VTVM reading should be greater than 550 mV.

6-8. Level Sensing Circuit

a. Connect SIGNAL input connector on one 0 dB output of attenuator and REFERENCE input connector to other 0 dB output.

b. Set signal generator to 1 kHz and output level to zero. Depress both .040 to 0.5V RMS level range switches.

c. Increase signal generator output level slowly and note points at which the high limit lamps turn on. Adjust R317 and R417 on input board A2 (fig. 6-3) so that both high limit lamps light at an input level between 470 mV RMS and 490 mV RMS.

6-9. Input Capacitance

a. Connect SIGNAL input connector to one 0 dB output of attenuator and REFERENCE input connector to other 0 dB output.

b. Set signal generator to 500 kHz and output level to 100 mV RMS. Depress both .040 to 0.5V RMS level range switches.

c. Note phase reading (dc meter reading, with meter connected across P1B-6 and P1B-9 on rear panel).

6-4. TEST PROCEDURE

Perform the Phasemeter Calibration in accordance with paragraph 3-3.

Perform the tests in accordance with figures 6-5 and 6-6. If all readings are within specified limits, further calibration is not necessary and the unit can be returned to operation. If the readings are not within specified limits, remove the Phasemeter from its case to expose boards A1 and A2, then proceed with the steps detailed in the following paragraphs.

6-5. CALIBRATION

The full calibration procedure is performed with the Phasemeter removed from its case. Upon completion of this procedure, perform the tests in accordance with figures 6-5 and 6-6. If the readings are within limits, no further calibration is required. If the readings are not within limits, perform the adjustment procedures described in paragraphs 6-6 through 6-13.

Perform the calibration as follows:

a. Connect voltmeter to the DC analog output of the Phasemeter (pins 6 and 9 of P1B on rear panel).

b. Allow a warm-up period as recommended by the manufacturer of the laboratory voltmeter and at least 1/2 hour for the Phasemeter.

c. Depress the "O" calibrate pushbutton. Adjust the screwdriver control below it for a 0.0 mV±0.1 mV reading.

d. Depress the "F.S" calibrate pushbutton. Adjust the screwdriver control below it for a 3600.0 mV $\pm$ 0.1 mV reading.

e. Select the -180° to +180° mode by applying -24 VDC to pin 2 of P1B on the rear panel. (-24 VDC is available on pin R of P1B.) Depress the "O" calibrate pushbutton and record reading. Depress the "F.S." calibrate pushbutton and record reading. Set the 180° offset by adjusting R511 on board A1 until the magnitudes of the readings in the "O" and "F.S." calibrate positions are equal. Readings should be $\pm$ 1800.0 mV $\pm$ 0.2 mV after adjustment.

f. Repeat steps c, d, and e, readjusting controls if necessary.

g. If the digital readout is in error, it may now be adjusted by screws on the DPM. (Refer to DPM instruction manual for location of adjustments.)

d. Connect 1K ohm resistor in series with the Signal input (between cable and assembly No. 101573).

e. Adjust Signal channel input capacitor C105 on board A2 for a phase difference of 13.0 ± 0.1 degrees (130 mV ± 1 mV) from the value noted in step c.

NOTE

If it is not possible to set 13.0 degrees in any step, change the oscillator frequency until it is possible and repeat all steps starting with step e.

f. Move the 1K ohm resistor to the REFERENCE input.

g. Adjust Reference channel input capacitor C207 on board A2 for a phase difference of 13.0 ± 0.1 degrees (130 mV ± 1 mV) from the value noted in step c. Remove 1K ohm series resistor.

h. Connect SIGNAL input connector to one 0 dB output and REFERENCE input to other 0 dB output.

i. Set signal generator output to 1.0 volt rms at 500 kHz. Depress both 0.4 to 5.0 V RMS level range switches.

j. Note phase reading.

k. Connect 1K ohm resistor in series with the Signal input.

l. Adjust Signal channel 20 dB attenuator input capacitor C114 on board A2 for a phase difference of 13.0 ± .1 degrees (130 mV ± 1 mV) from the value noted in step j.

m. Move the 1K ohm resistor to the REFERENCE input.

n. Adjust Reference channel 20 dB attenuator input capacitor C215 on board A2 for a phase difference of 13.0 ± 0.1 degrees (130 mV ± 1 mV) from the value noted in step j. Remove 1K ohm series resistor.

o. Set generator output to 10 volts rms at 500 kHz. Depress both 4-50 V RMS level range switches.

p. Note phase reading.

q. Connect 1K ohm resistor in series with the Signal input.

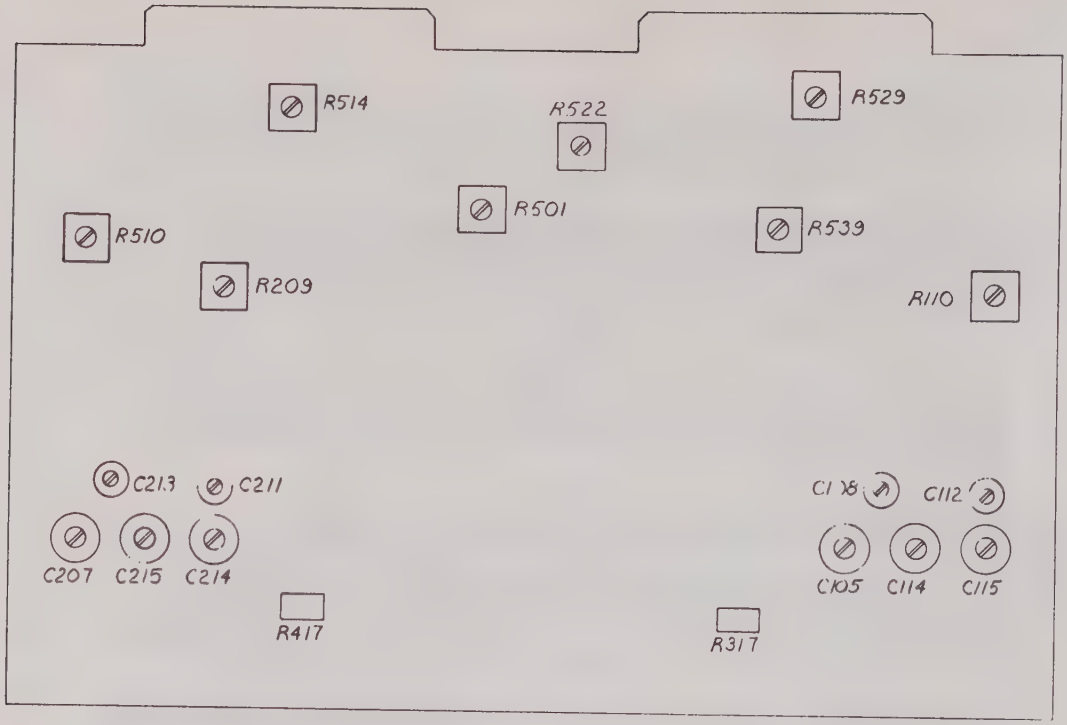

Figure 6-3. Input Board A2, Location of Adjustments.

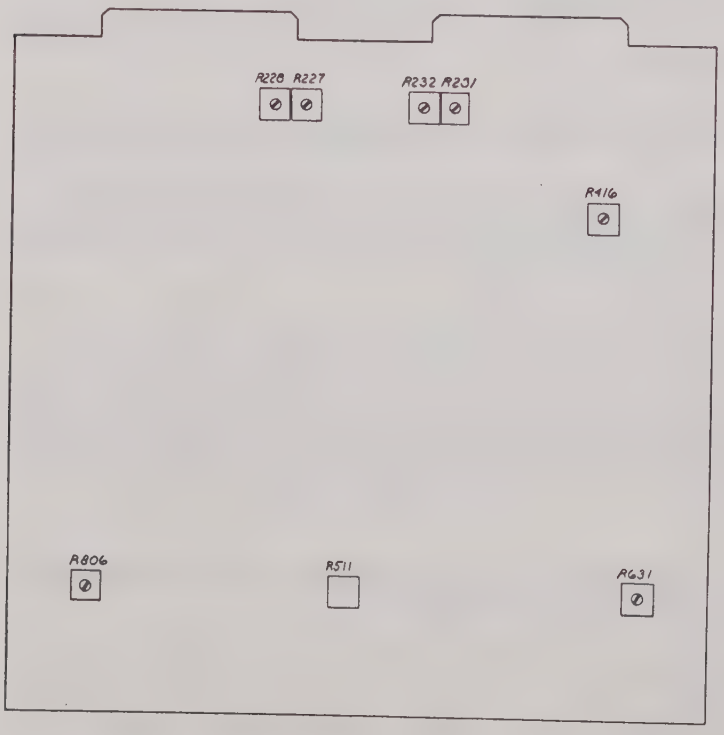

Figure 6-4. Phase Detector Board A1, Location of Adjustments.

d. Adjust R514 on board A2 for minimum phase error in the 10 kHz to 50 kHz frequency range.

e. Adjust R501 on board A2 for minimum phase error in the 50 Hz to 10 kHz frequency range.

f. Connect the REFERENCE input to the 0 dB output and the SIGNAL input to the -14 dB output.

g. Adjust R539 on board A2 for minimum phase error in the 10 kHz to 50 kHz frequency range.

h. Adjust R522 on board A2 for minimum phase error in the 50 Hz to 10 kHz frequency range.

6-13. Input Attenuator Phase Match

a. Run line #1 on data sheets of figures 6-5 and 6-6. This data will be used as a standard for attenuator phase adjustments which follow. When setting the attenuator phase shifts, they should be matched to the numbers on line #1 rather than set to the ideal value of zero degrees. This method assures that the attenuators will match each other as well as matching the direct input run of line #1.

b. Set oscillator (signal generator) and connect attenuator in accordance with line #2 of data sheets. Depress the REFERENCE 0.4 to 5.0V RMS level range switch and the SIGNAL .040 to 0.5V RMS level range switch.

c. Set phase shift of Reference channel 20 dB attenuator by adjusting C213 on board A2 for minimum deviation from line #1 at 5 kHz.

d. Run line #2 on data sheets of figure 6-5 and 6-6 (dc output and digital panel meter reading).

e. Set up for data sheets lines #3. Depress the SIGNAL 0.4 to 5.0V RMS level range switch and the REFERENCE .040 to 0.5V RMS level range switch.

f. Set phase shift of Signal channel 20 dB attenuator by adjusting C108 on board A2 for minimum deviation from line #1 at 5 kHz.

g. Run line #3 on data sheets of figures 6-5 and 6-6.

r. Adjust Signal channel 40 dB attenuator input capacitor C115 on board A2 for a phase difference of 13.0 ± 0.1 degrees (130 mV ± 1 mV) from the value noted in step p.

s. Move the 1K ohm resistor to the Reference input.

t. Adjust Reference channel 40 dB attenuator input capacitor C214 on board A2 for a phase difference of 13.0 ± 0.1 (130 mV ± 1 mV) degrees from the value noted in step p. Remove 1K ohm series resistor.

6-10. High Frequency Response

a. Connect both inputs to the 0 dB attenuator outputs.

b. Set signal generator to 50 kHz at an output level of 250 mV RMS. Depress both .040 to 0.5V RMS level range switches.

c. Connect a jumper between pins P1A-4 and P1B-11 on the connector between boards A1 and A2.

d. Set potentiometers R806 and R631 on board A1 (fig. 6-4) fully counterclockwise.

e. Adjust either R806 or R631 for a zero degree phase reading.

6-11. Frequency Response Match

a. Connect both inputs to the 0 dB attenuator outputs. Depress both .040 to 0.5V RMS level range switches.

b. Set oscillator output to 100 mV rms at 50 kHz.

c. Adjust either R529 or R510 on board A2 for a zero degree phase reading.

6-12. Level Sensitivity

a. Set generator output to 250 mV rms. Depress both .040 to 0.5V RMS level range switches.

b. Connect one 0 dB output of the attenuator to the SIGNAL input.

c. Connect -14 dB output to the REFERENCE input.

h. Run line #4 on data sheets. Depress both 0.4 to 5.0V RMS level range switches. If any points are out of tolerance, change the setting of C213 or C108 slightly on board A2. If any adjustment is required in this step, tests of lines 2 and 3 must be repeated.

i. Set up for line #5 of data sheets. Depress the REFERENCE 4.0 to 50V RMS level range switch and the SIGNAL .04 to 0.5V RMS level range switch.

j. Set phase shift of Reference channel 40 dB attenuator by adjusting C211 on board A2 to match line #1 at 5 kHz.

k. Run line #5 on data sheets.

l. Set up for line #6 of data sheets. Depress the SIGNAL 4.0 to 50V RMS level range switch and the REFERENCE .04 to .5V RMS level range switch.

m. Set phase shift of Signal channel 40 dB attenuator by adjusting C112 on board A2 to match line #1 at 5 kHz.

n. Run line #6 on data sheets.

o. Run data sheets lines #7. Depress both 4.0 to 50V RMS level range switches. If any points are out of tolerance, change the setting of C112 or C211 slightly on board A2. If any adjustment is required in this step, tests of lines 5 and 6 must be repeated.

LINE #	OSCILLATOR OUTPUT LEVEL V RMS	ATTENUATOR CONNECTORS REFERENCE	SIGNAL	Ø ERROR IN DEGREES AT TEST FREQUENCIES OF (DC METER READING) 5 Hz	50 Hz	500 Hz	5 kHz	50 kHz	500 kHz
1	0.1	0 dB	0 dB						
2	1.0	0 dB	-20 dB						
3	1.0	-20 dB	0 dB						
4	1.0	0 dB	0 dB						
5	10.0	0 dB	-40 dB						
6	10.0	-40 dB	0 dB						
7	10.0	0 dB	0 dB						
8	TOLERANCE LIMITS*			±1.03°	±0.13°	±0.13°	±0.13°	±0.13°	±1.03°

*TOLERANCE LIMITS INCLUDE ±0.03° (±0.3 MV) FOR DC DIGITAL VOLTMETER. IF ACCURACY OF VOLTMETER IS SIGNIFICANTLY BETTER THAN ±0.3 MV. THIS EXTRA ±0.03° SHOULD BE SUBTRACTED FROM EACH TOLERANCE LISTED.

Figure 6-5. Test Data Sheet with DC Meter Readings.

LINE #	OSCILLATOR OUTPUT LEVEL V RMS	ATTENUATOR CONNECTORS REFERENCE	SIGNAL	Ø ERROR IN DEGREES AT TEST FREQUENCIES OF (DIGITAL PANEL METER) 5 Hz	50 Hz	500 Hz	5 kHz	50 kHz	500 kHz
1	0.1	0 dB	0 dB						
2	1.0	0 dB	-20 dB						
3	1.0	-20 dB	0 dB						
4	1.0	0 dB	0 dB						
5	10.0	0 dB	-40 dB						
6	10.0	-40 dB	0 dB						
7	10.0	0 dB	0 dB						
8	TOLERANCE LIMITS			±1.2°	±0.2°	±0.2°	±0.2°	±0.2°	±1.2°

Figure 6-6. Test Data Sheet with Digital Panel Meter Readings.

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